524

JUL 27 1942

TRANSACTIONS
of
THE NEW YORK ACADEMY OF SCIENCES

Ser. II, Vol. 3 MAY, 1941 No. 7

SECTION OF GEOLOGY AND MINERALOGY

APRIL 7, 1941

PROFESSOR ERNST CLOOS, The Johns Hopkins University, Baltimore, Md.; *Flowage and Cleavage in Appalachian Folding.* (This lecture was illustrated by lantern slides.)

Quantitative determinations of the amount of deformation due to folding are rarely successful because of the lack of reference values on which measurements can be based. Bedding planes can be assumed to have been more or less horizontal before folding. The amount of lateral shortening of beds due to pure folding can, therefore, be measured, and is closely linked to proportional thickening and the accumulation of material in a smaller area. Attempts have been made to calculate such shortening and thickening on the basis of folds. Three factors, however, upset these determinations: faulting and thrusting, cleavage, and rock flowage. Reverse faults and thrusts tend to increase the factor for lateral shortening, normal faults tend to decrease it. Flowage is probably the most evasive factor since little is known about rock flowage. Cleavage is closely related to rock flowage (flow cleavage), and whenever prominent cleavage

TRANSACTIONS of The New York Academy of Sciences, Series II, Volume 3, No. 7, May, 1941.

This publication is distributed to Members and is published monthly from November to June, inclusive, at 8–10 W. King Street, Lancaster, Pa., by The New York Academy of Sciences, Seventy-ninth Street and Central Park West, New York City.

Associate Editor: Eunice Thomas Miner, Executive Secretary.

Entered as second-class matter December 2, 1938, at the post office at Lancaster, Pa., under the act of August 24, 1912.

appears, an appreciable amount of flowage must be taken into consideration.

New methods have been introduced in recent years in an attempt to analyze deformation and its directions in all its stages. Structures and mineral orientations are measured statistically and in great detail. However, the results obtained are, as a rule, not quantitative.

Quantitative measurements are possible, however, if the original shapes of deformed units are known. Observation of distorted fossils, elongated pebbles or amygdules and other forms have been recorded, but systematic measurements have rarely been undertaken. The purpose of the present paper is to introduce a method which may contribute to the systematic and quantitative analysis of rock flowage in relation to the formation of flow cleavage in non-crystalline rocks of certain portions of the Appalachians.

OOLITES

Oolites are abundant in many sedimentary formations, and in the Appalachian area they are particularly abundant in the Cambro-Ordovician limestones. As a rule, the oolites are originally spherical bodies which are evenly distributed in definite beds and can be traced laterally for many miles. The oolitic beds are folded and many of the individual oolites show deformation into ellipsoids. The deformation of oolites is rarely mentioned in the literature and the author has found no mention of the systematic analysis of such deformation. The wide distribution of oolitic rocks and the possibility of accurate measurements of the deformation of the individual spheres seem to render oolites ideally suited for a systematic statistical analysis of the degree and direction of deformation.

A systematic study was begun in a selected area west of South Mountain in Washington County, Maryland. The results so far obtained justify a preliminary communication. Measurements should be obtained from many localities and the area is too large to be covered by one investigator.

Eisb
New York Academy of Science
8.65.42

METHOD

A great deal of time can be saved if the area to be investigated is mapped geologically.

Measurements of the amount and directions of deformation are essential. Since spheres are deformed into tri-axial ellipsoids, three axes should be measured. Two thin sections at right angles to each other and oriented in space serve this purpose. Careful orientation is essential and determines the value of all later measurements. In both sections the axes of the ellipses are measured with a micrometer. From 80 to 100 measurements are necessary in order to obtain average values and eliminate originally ellipsoidal forms. In this way the ratios of the axes of deformation and their orientations can be ascertained at any locality where oolites are found. These values can be plotted on maps and sections and if a sufficient number of ratios are measured at many localities, lines of equal ratios may be constructed.

In addition, other observations should be recorded. The oolites vary in composition, size, and shape. Some are surrounded by concentric shells, others contain cores of dolomite, calcite, quartz, feldspar, fossils and other particles. Shells and cores distinctly influence the deformation, and may prevent intense elongation. Many of the measured axes may, therefore, represent minima and not indicate the total amount of extension.

All visible structures in the immediate vicinity of the specimen should be carefully recorded. Bedding, cleavages, lineations, fractures, and fold axes should be measured and plotted with the oolite axes. These will show local deviations in contrast to regional directions of deformation.

TENTATIVE RESULTS

In the following, the results of a reconnaissance study are presented. Seventy thin sections were made from 35 localities in Washington County, Maryland, and in the Chambersburg quadrangle, Pennsylvania. All the oolites were collected from Cambro-Ordovician limestones.

Hagerstown Valley is in a limestone belt which reaches from

the Susquehanna River through Maryland into West Virginia and far to the south. East of this belt are the metamorphosed volcanic rocks of South Mountain. From here westward one passes from basal Cambrian upward into the Ordovician.

A strong cleavage, strikes parallel to the fold axes (NNE) and dips consistently east between 20 and 50 degrees. A strong lineation is visible within the cleavage planes of all rocks, including the volcanics. Lineation and cleavage are most intense in the volcanics, and fade out gradually westward and disappear in the limestones near Hagerstown. South Mountain uplift is a large overturned fold and its axial plane cleavage dips gently eastward. Consequently, many of the formations along the west flank of the uplift are overturned, but in normal sequence.

Systematic measurements of oolite deformation were undertaken in several sections across the regional strike.

The ratio: $\frac{\text{long}}{\text{short}}$ axes was measured in thin sections containing the longest and shortest axes. Those ratios are from west to east (Hagerstown to South Mountain): 1.42, 1.45, 2.10, 4.20, 4.45, 5.60, 7.00. The distance between the first and last values is six miles.

The measured ratios were recalculated in terms of extension of the sphere in relation to a unit sphere. These values were then expressed as per cent of extension and the sections showed 18, 20, 44, 105, 115, 138, and 165 per cent. The direction of the maximum elongation is in all cases in the steepest dip of the cleavage plane.

The data gathered so far show clearly that the intensity of deformation increases gradually from Hagerstown toward the summit of South Mountain. There are no abrupt changes, but the area west of the South Mountain uplift has been affected as a whole. The gradual increase of ratios and the normal sequence observed in the field seem to exclude the possibility of a far-reaching overthrust along the western slope of South Mountain.

Folding in this area is accompanied by flowage up to 165 percent and in the direction parallel to the dip of cleavage planes. In the volcanic rocks the ratio is higher if amygdules and sericite

and chlorite blebs are measured. In the dolomites adjacent to the uplift, the ratio is so high ($> 7 : 1$) that oolites are largely obliterated. If the ratio exceeds 7 : 1, oolitic bodies are elongated too far for accurate measurements. In view of this high degree of deformation, it seems possible that the highly deformed limestones and dolomites may have been oolitic originally and also may have contained fossils.

Many of the beds in which high ratios were measured are vertical or dip steeply. The longest axes of the ellipsoids, however, are almost perpendicular to the bedding plane (70–90°) and transect these at a high angle. It is clear that flowage has increased the thickness of beds and possibly of whole formations. Measurements of stratigraphic thicknesses in such areas may be subject to revision, and local variations of thicknesses may be due to deformation and not to sedimentation.

Cleavage (flow cleavage) was found to be in the plane which is determined by the longest and mean axis of the deformed oolites. In the area adjacent to the South Mountain uplift, the longest oolite axis is in the steepest dip of the cleavage. West of Hagerstown, it was found to be parallel to the strike of the cleavage planes. Upward from a ratio of 1.3 : 1 cleavage appears and becomes more conspicuous with increasing ratio. The author is fully convinced that cleavage is parallel to the direction of maximum rearrangement of particles due to flowage. The actual extension of particles necessary for the development of cleavage is only approximately 20 per cent. The author is fully aware of the fact that these values are tentative and that generalizations will have to await a more detailed investigation.

Outside of the area in which the influence of the South Mountain uplift is observed, oolites are also deformed but their ratios do not exceed 1.2 or 1.25. Accordingly, all orientations are related to local structures like anticlines or synclines. A general eastward dip of cleavage and maximum oolite axes was not observed. Both are in the axial plane which may be vertical or inclined in conformity with the surrounding major structure.

The Appalachians form an arcuate structure with Baltimore

approximately at its center of curvature. Along the inner side of this arc the major oolite axes are radiating outward and converging inward. Proceeding outward (westward) a zone appears where the ratios are low (1.18–1.25) and regional arrangements are not felt. Still farther outward the maximum elongation is parallel to the subhorizontal fold axes, and the ratio increases again (2.00 near Hearthstone Mtn., south of Mercersburg). It seems as if the arcuation had produced a measurable amount of elongation in the direction of the fold axes. If measured on a geologic map, this elongation is about 10–15%, a value of the same order of magnitude as that measured in the deformed oolites.

Lateral shortening of a series of strata by folding is necessarily accompanied by thickening of the entire complex. If the folded complex is 25,000 feet thick and shortening amounts to 50%, the total thickness would become 50,000 feet. Arcuation parallel to fold axes tends to reduce this value. Flowage parallel to cleavage planes may reduce this thickness still more. One hundred per cent extension, as measured near the South Mountain uplift, tends to reduce the thickness by the same amount since it may safely be assumed that the volume of rock has not changed appreciably.

From observations of flowage in oolitic limestones, the author concludes that flowage is a much more important factor than has heretofore been taken into consideration. The limestones west of South Mountain were flattened considerably during folding, and it may be that in an analysis of Appalachian folding this flowage factor has to be considered as most important.

Since oolitic formations are abundant in the Appalachian region, it should be possible to determine the directions of deformation and the amount of rock flowage at many localities with considerable accuracy.

SECTION OF BIOLOGY

April 14, 1941

Professor Rudolf T. Kempton, Vassar College; *The Problem of Renal Secretion.* (This lecture was illustrated by lantern slides.)

It has been demonstrated by Richards and his co-workers that the first step in urine formation is the ultrafiltration of blood through the walls of the glomerular capillaries. The protein-free filtrate, during its passage along the tubule, becomes highly modified to form the urine characteristic of the species. Perhaps the main process in this change is reabsorption, the return of materials from the lumen of the tubule to the blood in the capillaries surrounding the tubules. Richards and his co-workers have further shown that sugar is reabsorbed from the proximal segment of the amphibian tubule, and chloride from the distal; while water reabsorption is performed mainly by the distal tubule. Probably the reabsorption is conducted in two ways. The removal of sugar or chloride from the filtrate in the amphibia involves cell work. Reabsorption of water from the mammalian tubule similarly requires cellular energy. If, however, substances remain in the tubule during water reabsorption, their concentration may be raised to the point at which outward diffusion into the blood can be prevented no longer. Thus there is a form of reabsorption in which direct cell activity is not involved, the substance merely diffusing outward into the blood.

A second process involved in the elaboration of urine may be that of secretion, the passage of materials from the peritubular capillaries through the walls of the tubule into the lumen. As shown by Smith, Marshall and others, some species of teleostomous marine fish are without glomeruli, the entire renal elimination being secretory. However, glomeruli are usually present in kidneys, and in this case secretion is a process added to the glomerular elimination. Strangely, more foreign synthetic compounds

are secreted than normal urinary constituents. However, there is reason to believe that the process is not restricted to foreign materials.

Secretion can be visualized best in tissue cultures of fragments of kidney tubules. In such preparations, the torn ends of the tubules become healed quickly, forming closed segments. If phenol red, an indicator dye, is then added to the medium, the dye enters the proximal tubule cells, passes into the lumen, and there becomes highly concentrated. The dye is red in the alkaline medium, yellow in the slightly acid cells, and red in the lumen. The substance thus passes from a low concentration in the medium to a high concentration in the lumen. This is, of course, in a direction opposite to that expected on the basis of simple diffusion. Interference with the metabolism of the cells prevents this concentration; or, if the concentration had previously occurred, it cannot be maintained and the dye diffuses back into the medium. The mechanism which produces such secretion still remains obscure.

Neutral red is another substance secreted by the intact kidney. Richards and Reisinger have shown that, in the frog, it is eliminated mainly by secretion rather than by filtration at the glomerulus. It is a well known characteristic of neutral red that it follows a pH gradient in either an artificial system or in living cells in general, passing from an alkaline medium to a more acid medium. Evidence has been obtained by Chambers and Kempton which indicates a similar behavior in the intact kidney. The dye appears to diffuse from the alkaline blood or perfusion fluid into the slightly acid cells and thence into the more acid lumen. Upsetting of this pH gradient by the alkalinization of the urine results in a cessation of concentration of neutral red in the lumen; while an increase in the gradient, by increasing the acidification of the urine, results in increased dye output. This elimination continues even though the cells are narcotized, providing the pH gradient is artificially maintained. The secretion of neutral red is therefore a physical diffusion without the direct intervention of cell activity.

While the cause of secretion of neutral red appears to be clear, its method of elimination is quite different from that of phenol red. The secretion of the latter is independent of pH gradients, and is strictly dependent on the maintenance of cell metabolism. Phenol red secretion appears to be more typical of the problem than neutral red secretion.

Various microscopically visible structures in the tubule cells have at times been considered to be morphological secretory mechanisms. Golgi apparatus, mitochondria, vacuoles and globules have all been considered secretory structures. Evidence from various sources indicates that none of these correlations of structure with secretory function stands close scrutiny. Changes in mitochondria which have been associated with secretion of neutral red, for example, appear to be merely the result of the presence of neutral red, perhaps a toxic effect. In addition, the evidence cited above indicates that it is not necessary to hypothecate a structural secretory mechanism for this substance. Vacuoles of concentrated phenol red described in the tubule cells of frogs eliminating this substance are not secretory mechanisms, because, in tissue cultures, secretion of phenol red occurs in the absence of such vacuoles; and, when such vacuoles are present, they do not empty their contents into the lumen. Globules in the proximal tubule cells of Necturus appear to be correlated with the presence of foreign materials in the abdominal cavity instead of being correlated with either secretion or reabsorption. Unpublished studies made by Ruth Castle in our laboratories indicate that there is no direct correlation between secretion and mitochondria or between secretion and the Golgi apparatus. We conclude from the evidence that there is no structure which can be seen under the microscope which is a definite secretory mechanism.

Entrance of secreted substances into the cell and their transport from base to apex of the cell can be separated from the problem of passage into the lumen. The evidence, at the present time, indicates that entrance into the cell and its transport from one end of the cell to the other can be explained on the basis of

diffusion, and that the process of secretion is concerned with the passage of the material across the cell membrane which separates the cytoplasm from lumen. In the first place, the apical cell membrane appears to allow passage of dye through it in only one direction. It is obvious that in tissue cultures of secreting tubules the dye is passing from the cell cytoplasm into the lumen through this membrane. On the other hand, if phenol red is injected into the tubule of a kidney with intact circulation, and the tubule blocked to prevent the dye being washed along the tubule by the glomerular filtrate, this dye remains visible over long periods of time. So far as can be determined by microscopic examination, the dye does not enter the cells from the lumen. Even when highly concentrated solutions of dye are injected, the color of the tubule cells remains unchanged. This membrane, therefore, appears to have a one-way permeability, in so far as direct observation can establish this possibility. The basal end of the cell, on the other hand, appears to be freely permeable in both directions to phenol red. This is indicated by two lines of evidence. First, while it is true that in tissue cultures the tubule cell cytoplasm may contain more highly concentrated dye than the medium, this may be due to binding of the dye molecules to the cytoplasmic proteins with resulting immobilization, as far as diffusion is concerned. That this is the explanation, rather than some peculiarity of the basal cell membrane, is indicated by the result of interfering with cell activity. When cultures, in which tubules contain concentrated dye, are treated to inhibit cell activity, the dye diffuses outward. Since this treatment removes the one-way permeability of the apical cell membrane, it is to be expected that any one-way permeability of the basal membrane is suppressed likewise. However, when equilibrium is reached, it is found that the dye concentration in the cell is unchanged. Since, under these new conditions, the dye continues to be more concentrated in the cytoplasm than it is outside, it follows that the relationships across the membrane have remained unchanged and that there must have been a free permeability of this membrane originally. Secondly, the coloration of the cells varies

with the concentration of phenol red within them. If small amounts are present, it is all converted to its acid yellow state. With higher concentrations, some of the phenol red retains its red color, while the coloration of the cytoplasm becomes orange. With increasing concentrations, all shades of orange are attained until the yellow is quite submerged and the cell appears red. In a series of cultures with varying concentrations of phenol red, all the proximal tubules of a given culture attain the same color and shade. On the other hand, there is great variation in the different tubule fragments as to the amount of concentration within the lumen. The color of the cells appears to vary consistently with the concentration of dye in the medium, and not at all with the amount of secretion into the lumen. The most logical explanation is that the entrance of dye into the cells is physical diffusion, while its passage into the lumen is correlated with cellular metabolism. We therefore conclude that the basal cell membrane is freely permeable in both directions to phenol red, but the distal membrane allows only one-way passage. Diffusion explains the entrance of the dye into the cell and its movement from base to apex of the cell. Secretion, involving cell work, is the passage of dye across the cell membrane which separates cytoplasm from lumen.

One explanation of this apparent one-way passage across the apical cell membrane is that the configuration of the membrane is such that it permits the passage of dye molecules through it in one direction but not in the other. This configuration might be maintained by cell activity. While this is possible from the viewpoint of colloidal chemistry, there is no direct evidence at the moment which proves that the apical cell membrane is of this nature. Attempts will be made to obtain critical evidence. It seems worth while to point out, however, that if such a membrane were present it would act as a secretory mechanism. When two concentrations of a dye are separated by a freely permeable membrane, the net change is a passage of the dye from the more concentrated solution to the less concentrated until equilibrium is reached. However, dye molecules are actually passing in both

directions, and the final result is due to difference in the number of molecules passing each way. If such a membrane were replaced by one allowing passage in only one direction, molecules could continue to pass from the lower concentration to the higher, but not in the opposite direction. The net result would be an apparent reversal of the usual diffusion. If this new membrane were the cell membrane, and, if this characteristic were maintained as a result of cell activity, dye could pass from its lesser concentration in the cell to the higher concentration within the lumen of the tubule. In other words, secretion of phenol red would result from the physical structure of the apical cell membrane.

A complete explanation of secretion must take into consideration the presence of mechanisms for the concentration of materials of recent origin. Smith and Marshall have suggested that this is due to the persistence of a primitive condition now little used for normal urinary constituents. In connection with the secretory mechanism suggested above, it should be pointed out that one of the most characteristic features of tubule cells is that they present a barrier to the outward diffusion of materials from the higher concentration within the lumen to the lower concentration outside. It seems likely that this is a characteristic of the membrane between cell and lumen, for otherwise the cytoplasm would have to be in equilibrium with a very unusual medium, in some cases very hypotonic and in other cases very hypertonic. This barrier to outward diffusion is dependent on cell activity. If this barrier prevents the outward diffusion of phenol red molecules, along with others, while permitting the inward diffusion of phenol red, it could be the mechanism for secretion. Thus, this barrier to outward diffusion, which has evolved through thousands of years, could "inadvertently" secrete a substance synthesized for the first time in the twentieth century.

Whether this suggested secretory mechanism is correct or incorrect, it appears at the present time that it is not necessary to invoke a secretory mechanism to explain the entrance of

secreted substances into the cell or their distribution through the cell. It further appears that the Golgi apparatus, mitochondria, vacuoles, globules and other microscopically visible cell components are not responsible for the secretory process. The evidence points toward a secretory mechanism which is much more subtle than this and probably of sub-microscopic dimensions.

SECTION OF PSYCHOLOGY

April 21, 1941

Doctor Frank K. Shuttleworth, College of the City of New York; *Problems and Techniques Involved in the Appraisal of Vocational Opportunities.*

The vocational guidance of high school and college students is one of the important functions of applied psychologists. Good guidance depends on the evaluation of individual aptitudes and the correct appraisal of vocational opportunities. The factor of opportunities is of special interest at the college level because most college students have the abilities, aptitudes and interests appropriate to any one of several fields of work. The Student Personnel Bureau at The City College has recently surveyed its recent graduates in order to ascertain the most promising fields of work. The methods and technical problems involved in conducting such inquiries are of general interest and deserve discussion apart from the particular findings.

On the basis of experience gained in this survey the following suggestions concerning the collection of data may be offered. It is unnecessary to survey all of a series of recent graduating classes. Best results are obtained by surveying college alumni out of school four years. A complete 100% return from one group of 327 alumni suggests that an 80% questionnaire return, exclusive of insufficient addresses, is essential to give representative findings.

In the analysis of the collected data, alumni should be grouped according to undergraduate majors, and each such group should be sorted by educational and occupational status. We have distinguished five categories:—unemployed; in school; employed within the field of undergraduate training; employed outside the field of undergraduate training, but within a field for which a college education is essential; and employed at clerical or unskilled work. With these classifications available, the first

step is to appraise past opportunities as indicated by the proportions employed within the field of their training; by median annual earnings; by the extent to which a given field of work attracts alumni from unrelated major fields of study; and by the rewards that different types of employment pay to alumni having the same training. The bare statistical findings on each of these four criteria of past opportunities must be corrected for many complicating factors. For example, the proportion of chemistry majors employed as chemists is low because many are still in school. Again, City College alumni who are practicing law report very low earnings, because all have been employed less than a year. The exact weight to be given to these four criteria is a matter of judgment. Having evaluated past opportunities, the next step is to evaluate opportunities for the immediate future. Four major changes in the outlook must be noted. First, there are the uncertainties introduced by the war; second, teaching opportunities in the academic field in New York City are virtually closed; third, opportunities for the City College graduate in the study of medicine have continued to contract; fourth, the number of undergraduates preparing for social work has increased greatly, thus increasing competition for the available jobs. The uncertainties introduced by the war are wholly unpredictable, but the influence of the other three changes may be estimated with some precision. Were it not for the uncertainties of the war, it is believed that past opportunities corrected for these changes would yield surprisingly accurate predictions of the findings of another survey conducted in the immediate future.

ASTRONOMICAL CONFERENCE

MAY 2 and 3, 1941

Conference on "The Fundamental Properties of the Galactic System."

Doctor Harlow Shapley, Director, Harvard Observatory, was in charge of this meeting as Conference Chairman.

The program consisted of the following papers:

"The Reference System of Stellar Positions," by H. R. Morgan.

"The Reference System With a View to Planetary Dynamics," by Dirk Brouwer.

"Mean Parallactic Motions," by Peter van de Kamp.

"Mean Parallaxes from Tau-components," by Emma T. R. Williams.

"The Luminosity Function," by W. J. Luyten.

"The Luminosity Function and the Absorption in the Galactic Plane," by Jan Schilt.

"The Magnitude Scale," by Frederick H. Seares.

"The Stellar Distribution in Intermediate Latitudes," by B. J. Bok and D. A. MacRae.

"On the Dimensions of the Galaxy," by Harlow Shapley.

The papers presented at this conference will be published as one article in the Annals of the Academy at a later date.

NEW MEMBERS

Elected April 7, 1941

LIFE MEMBERS

Beecher, Henry K., M.D., Anesthetist-in-Chief, Massachusetts General Hospital, Boston, Mass.

Bird, Whitworth F., B.S., Director, Research & Technical Control, Collins & Aikman Corp., Philadelphia, Pa.

ACTIVE MEMBERS

Aldecoa, Eladio R., D.D.S., President, College of Oral & Dental Surgery, Manila, P. I.

Austin, Thomas Herwood, M.A., Graduate Assistant, Zoology, Yale University, New Haven, Conn.

Ball, C. Olin, Ph.D., Assistant to Director of Research, American Can Company, New York, N. Y.

Ballou, Charles H., B.S., Professor, Entomology, Estation Experimental de Agricultura y Zootecnica, Caracas, Venezuela, S. A.

Barondes, R. deRohan, M.D., Oneology, San Francisco, California.

Bartlett, Russell Sturgis, Ph.D., Research Fellow, Physics, Newark College of Engineering, Lexington, Mass.

Beckwith, Edward P., B.S., Research Chemist, Garrison, N. Y.

Beers, Norman R., B.Sc., Physics, Astrophysics, McGraw-Hill Book Company, Inc., New York, N. Y.

Berastegui, Henry, E.E., Central Office Engineer, Western Electric Co., Inc., Kearny, N. J.

Berg, Ernst J., Sc.D., Professor, Electrical Engineering, Union College, Schenectady, N. Y.

Bishop, Louis Faugères, Ph.B., M.D., Clinical Professor, Cardiology, Fordham University, New York, N. Y.

Bittson, A. John, E.E., President, A. John Bittson Engineering Co., New York, N. Y.

Blount, Isabel H., Ph.D., Research Associate, Anatomy, University of Minnesota, School of Medicine, Minneapolis, Minn.

Blount, Raymond F., Ph.D., Assistant Professor, Anatomy, University of Minnesota, School of Medicine, Minneapolis, Minn.

Bovarnick, Max, Ph.D., Senior Medical Biochemist, New York State Department of Public Health, New York, N. Y.

Doubilet, Henry, M.D., M.Sc., Instructor, Surgery, New York University, New York, N. Y.

Farnsworth, Marie, Ph.D., Research Chemist, Metal & Thermit Corp., Jersey City, N. J.

Gresham, James R., B.A., Administrative Assistant, Nutrition Study, U. S. Public Health Service, New York, N. Y.

Joseph, Barnet, M.D., Physician, Chemistry, New York, N. Y.

Joy, Stephen Lowell, B.S., Graduate Student, Psychology, Columbia University, New York, N. Y.

Kirner, Walter Raymond, Ph.D., Organic Research Chemist, Coal Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa., on leave for Defense Service, Technical Aide, National Defense Research Committee, Chevy Chase, Md.

Kraus, Walter Max, M.D., Physics, Chemistry, New York, N. Y.

Krumrein, Louis F., M.D., Instructor, Clinical Medicine, Johns Hopkins University, School of Medicine, Baltimore, Md.

Lacaillade, C. William, Ph.D., Professor, Zoology, St. John's University, Brooklyn, N. Y.

Lascoff, J. Leon, Ph.D., Sc.D., Pharmacy, President, J. Leon Lascoff & Son, New York, N. Y.

Lehrman, Philip Raphael, M.D., Clinical Professor, Neurology and Psychiatry, Columbia University, New York, N. Y.

Lenz, William Joachim, M.D., Ph.D., Chemistry, President, Lenz Testing Laboratories, Louisville, Ky.

Levine, Philip, M.D., Bacteriologist, Newark Beth Israel Hospital, Newark, N. J.

Locatcher-Khorazo, Devorah, M.D., Assistant Bacteriologist, Columbia University, New York, N. Y.

Long, Perrin Hamilton, M.D., Professor, Preventive Medicine, Johns Hopkins University, School of Medicine, Baltimore, Md.

Loofbourow, John R., Sc.D., Associate Professor, Biophysics, Massachusetts Institute of Technology, Cambridge, Mass.

Lorand, Eugene J., D.Eng., Research Chemist, Hercules Powder Company, Wilmington, Del.

Lowrey, Lawson G., M.D., Psychology, Director, Brooklyn Child Guidance Clinic, Brooklyn, N. Y.

Lynch, Joseph P., M.A., Instructor, Biology, Fordham University, New York, N. Y.

MacColl, LeRoy A., Ph.D., Member research staff, Bell Telephone Laboratories, New York, N. Y.

McComas, Henry C., Ph.D., President, H. C. McComas Coal Company, Baltimore, Md.

Maher, Chauncey C., M.D., Assistant Professor, Medicine, Northwestern University Medical School, Chicago, Ill.

Major, Randolph T., Ph.D., Chemistry, Director of Research, Merck & Company, Inc., Rahway, N. J.

Mann, Paul Blakeslee, A.M., Biology, Head, Evander Childs High School, New York, N. Y.

Menzel, Arthur E. O., Ph.D., Chemistry, Nyack, N. Y., Research Associate, Squibb Institute for Medical Research.

Minor, Ralph S., Ph.D., Professor, Physics, Optometry, University of California, Berkeley, Calif.

Pritchard, Miriam C., Ph.D., Research Associate, Educational Psychology, Teachers College, Columbia University, New York, N. Y.

Quayle, Osborne Robinson, Ph.D., Professor, Chemistry, Emory University, Emory University, Ga.

ASSOCIATE MEMBERS

Arnold, Charles Harrison, M.D., Surgeon-in-Chief, Green Gable's Sanitarium, Lincoln, Nebr.

Ayer, Guy Darrell, Jr., M.D., Pathological Anatomy, Director, Otsego County Public Health Laboratory, Cooperstown, N. Y., On leave for Defense Service, Company D, First Medical Battalion, First Division, Fort Devens, Mass.

Bailey, Edna W., Ph.D., Professor, Education, University of California, Berkeley, Calif.

Bailey, Paul E., M.S., Assistant Professor, Chemistry, Loyola University, New Orleans, La.

Banks, Burnwell Bernard, M.S., Professor, Chemistry, Mary Allen Junior College, Crockett, Texas.

Barclay, Earle Herbert, Ch.E., Ph.D., Chemical Engineering, Manager, Kuppr Bros. Co., Northbridge, Mass.

Beezer, Gerald R., M.Sc., Professor, Chemistry, Seattle College, Seattle, Wash.

Beltz, J. Carl, Ph.D., Instructor, Chemistry, State Teachers College, St. Cloud, Minn.

Bennett, Mary Allison, Ph.D., Associate Professor, Biology, Western Illinois State Teachers College, Macomb, Ill.

Berl, Ernst, Ph.D., Research Professor, Chemistry, Carnegie Institute of Technology, Pittsburgh, Pa.

Bigelow, Lucius A., Ph.D., Associate Professor, Organic Chemistry, Duke University, Durham, N. C.

Blanchet, Louis A. G., M.A., Teacher, Physics, New Orleans, La.

Blish, Morris J., Ph.D., Chief, Protein Division, Western Regional Research Laboratory, U. S. Department of Agriculture, Albany, Calif.

Blumenthal, Herman, D.O., Medicine, Chemistry, Philadelphia, Pa.

Hibbard, Claude W., Ph.D., Assistant Curator, Vertebrate Paleontology, University of Kansas, Lawrence, Kans.

Jefferson, Merrill E., B.S., Associate Physicist, Southern Regional Research Laboratory, New Orleans, La.

Korff, Serge A., Ph.D., Research Fellow, Physics, Bartol Research Foundation, Swarthmore, Pa.

Kropa, Edward L., Ph.D., Research Chemist, American Cyanamid Company, Stamford, Conn.

Lange, Mathilde M., Ph.D., Professor, Biology, Wheaton College, Norton, Mass.

Lenher, Samuel, Ph.D., Technical Manager, Fine Chemical Division, E. I. du Pont de Nemours & Company, Wilmington, Del.

Levine, Moses N., Ph.D., Pathologist, U. S. Department of Agriculture, St. Paul, Minn.

Light, Richard Upjohn, M.D., Neurological Surgery, Borgess Hospital, Kalamazoo, Mich.

Loeb, Leonard B., Ph.D., Professor, Physics, University of California, Berkeley, Calif. On leave for Defense Service, Commander, Naval Proving Ground, Dahlgren, Va.

Loefer, John B., Ph.D., Associate Professor, Biology, Berea College, Berea, Ky.

Loosanoff, Victor L., Ph.D., Marine Biology, Director, Fishery Biological Laboratory, Milford, Conn.

Lott, W. A., M.Sc., Head, Laboratory for Medicinal Chemistry, Squibb Institute, New Brunswick, N. J.

Lueck, Roger H., M.S., Manager, Research Department, American Can Company, Maywood, Ill.

Lyon, Marcus Ward, Jr., M.D., Ph.D., Pathologist, South Bend Clinic, South Bend, Ind.

Lyons, Don Chalmers, Ph.D., Public Health Educator, Oral Surgeon, Jackson, Mich.

MacDougall, Frank H., Ph.D., Professor, Physical Chemistry, University of Minnesota, Minneapolis, Minn.

MacKay, Donald C. G., Ph.D., Assistant Professor, Zoology, University of Connecticut, Storrs, Conn.

McAdam, Dunlap J., Jr., Sc.D., Metallurgy, National Bureau of Standards, Washington, D. C.

McEwen, Robert S., Ph.D., Professor, Zoology, Oberlin College, Oberlin, Ohio.

McKeown, Raymond Meril, M.D., Medicine and Surgery, Marshfield, Oregon.

McLean, David A., Ch.E., Member of Technical Staff, Bell Telephone Laboratories, New York, N. Y.

Marshall, John Albert, D.D.S., Ph.D., Professor, Biochemistry, Dental Pathology, University of California Medical Center, San Francisco, Calif.

Mason, John Philip, Ph.D., Professor, Chemistry, Boston University, Boston, Mass.

Mason, Karl E., Ph.D., Professor, Anatomy, University of Rochester, School of Medicine, Rochester, N. Y.

Millis, John, B.S., Geology, Physics, Retired Colonel, U. S. Army, Cleveland, Ohio.

Mogendorff, Nicholas, Ph.D., Associate Professor, Natural Science, University of Toledo, Toledo, Ohio.

Twitchell-Allen, Doris, Ph.D., Psychologist, Children's Hospital, Children's Convalescent Home, Cincinnati, Ohio.

STUDENT MEMBER

Costello, Timothy, M.A., Psychology, Graduate Assistant, New York University, New York, N. Y.